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HAY FEVER.

ITS CAUSE AND PREVENTION IN THE ROCKY MOUNTAIN AND PACIFIC STATES.

By WILLIAM SCHEPPEGRELL, A. M., M. D., New Orleans.

The pollens which cause hay fever in the Eastern and Southern States have been the subject of considerable investigation, and the principal pollens have been identified. West of Kansas, however, this subject has received little attention, most writers having contented themselves with the vague statement that hay fever in this region is uncommon.

Investigations during the past year, however, have shown that hay fever in this section, while not as common as a whole as in the Eastern and Southern States, is by no means infrequent and is, moreover, constantly increasing. Reports from California and Colorado show that hay fever is a common disease in these States. A correspondent in Santa Fe, New Mexico, states that there is a "great deal" of hay fever in that section. Another from the State of Washington claims that hay fever is exceedingly common. Reports also show that hay fever is common in Montana, Oregon, Idaho, Arizona, Wyoming, Utah, and Nevada. In view of this prevalence of hay fever in these States the need for a careful investigation of this subject is clearly indicated.

The main difficulty in establishing the exciting cause of hay fever[1] in this section is that the common and giant ragweeds (*Ambrosia elatior* and *trifida*), which are the usual cause of autumn hay fever (85 per cent) east of Kansas, are found west of the 100th meridian in insufficient quantities to be of importance in hay fever except in a few localities.

In correspondence with the various State boards of health of the Pacific and Rocky Mountain States, we found uniform interest in the subject of hay-fever prevention, but a lack of information as to the exciting causes of the disease. With a view, therefore, of obtaining definite information on this subject, we have conducted a series of investigations during the past 18 months, which has enabled us to determine the principal hay fever plants of this section.

Hay Fever Plants.

The identification of hay fever plants in general is simplified by the fact that they are all wind-pollinated. Many insect-pollinated and self-pollinated plants contain pollen which will produce the hay fever reaction in the biological test, but as their pollen is not found in the air and can not therefore reach the nasal passages in ordinary respiration, they are not responsible for hay fever.

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[1] The biological properties of the pollens described in this article have all been determined by direct tests on hay-fever subjects. In the unimportant pollens which have proved negative or, not being windborne, can cause hay fever only on direct inhalation, only a few tests have been made. In the important hay-fever pollens, however, many hundreds of tests (in the rag weeds several thousands) have been made in order to determine both qualitatively and quantitatively their responsibility in hay fever.

Wind-pollinated plants are characterized by inconspicuous flowers, which are without bright colors or scent, and by the large quantity of pollen which they generate.[1] Many wind-pollinated plants, however, have pollen which does not produce hay fever (pines, sedges, etc.), or which causes reactions of a mild character (amaranths (*Amaranthus*), docks (*Rumex*), chenopods (*Chenopodium*), etc.). These effects can be determined only by means of the biological test.

Biological Test for Hay Fever.

The method of making the biological test for hay fever is as follows: For the pollen of botanical genera which have not yet been tested, a weak saline extract (1 to 20,000) of the pollen is first used. Care should be taken that the saline solution used is a one-half of 1 per cent solution, as a stronger or weaker solution causes irritation of the nasal mucosa independent of the action of the pollen extract. When the subject fails to react to this weak extract, stronger extracts are applied. When these also prove negative, some of the pollen is applied directly as a final test.

The pollen extract is prepared by adding 1 centigram of the specified pollen to 10 c. c. of 5 per cent salt solution. After the soluble extracts have been dissolved, the liquid is filtered and 7 per cent alcohol added. When used for testing the reaction of a patient, or for immunizing, this is diluted so as to represent a pollen extract of 1 to 10,000 to 1 to 200,000 or more according to the toxicity[2] of the pollen used. In our research work, we are using a unit representing 0.001 milligram of pollen extract which has proved of practical value.

For the conjunctival reaction, the extract is applied to the conjunctival sac, the reaction being indicated by the hyperemia produced. The skin reaction is secured by making a number of light scratches on the skin and rubbing in a drop of the pollen extract to be tested. A positive reaction is indicated by reddening and edema of the area surrounding the abraded surface, accompanied by itching. In the hay-fever clinic of the Charity Hospital of New Orleans we use individual syringes in capillary tubes, by which a drop of the extract is injected into (not under) the skin. The reaction is similar to that obtained by scarifying the skin. The cutaneous tests have the advantage of being available when the patient is suffering from hay fever, when the conjunctival reaction is not practicable.

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[1] "Hay fever and its prevention," Wm. Scheppegrell, Public Health Reports, July 21, 1916.

[2] "Toxicity" in connection with pollens refers to the positive reaction in hay-fever subjects. The existence of a true toxin in hay-fever pollens is still under investigation.

Before enumerating the hay-fever plants of the Pacific and Mountain States, it will be well to make a brief resumé of the principal hay-fever plants of the Eastern and Southern States.

Principal Hay-Fever Plants of the Eastern and Southern States.

In this section, we have two distinct seasons of hay fever, which differ in the various States only in their dates and duration. The average dates for the two seasons of these States are May to July for the early form, and August to October for the autumnal form.

The early form of hay fever in this section is due principally to the pollen of the Gramineæ, which includes the grasses, both wild and cultivated, and some of the cereals such as rye, oats, and wheat. Theoretically, corn also is included, and is frequently referred to as a common cause of hay fever. The size of its pollen, however, is relatively so great (80 microns) that it causes few cases of hay fever and then only in close proximity to such crops. Rye and wheat also have large heavy pollen grains (50 microns) which gives them a limited potential area of distribution by the wind.

The trees, which are largely wind-pollinated and frequently distribute their pollen in enormous quantities, usually bloom in the spring, but are rarely responsible for hay fever. The pines (*Pinus scopulorum* and other species) are especially prolific in their pollen (fig. 1) but have always given a negative reaction in our biological tests. The pollen of some of the oaks, willows, ailanthus, and other trees give a mild reaction for hay fever, but not sufficiently to be of importance in a general consideration.

The autumn hay fever which forms about 65 per cent of all the cases, is due usually (85 per cent) to the pollen of the common ragweed (*Ambrosia elatior*, fig. 2), this being replaced in some sections by the giant ragweed (*Ambrosia trifida*, fig. 3). The remaining 15 per cent of cases are due to the pollen of other plants, of which the various species of cockle bur (*Xanthiums*) and the marsh elder (*Iva ciliata*) are the most important.

Hay-Fever Seasons in the Pacific and Rocky Mountain States.

In this region there are also two hay-fever seasons, but these have a greater tendency to merge and the fall hay fever usually commences earlier. The cause of this will be understood when the pollinating periods of the hay-fever plants are examined. The dates of the hay-fever seasons in these States are as follows:

State.	Spring and summer form.	Autumnal form.
Arizona	May 5–June 5	July 15–Oct. 1.
California	May 5–July 5	July 15–Sept. 15.
Colorado	May 10–July 1	July 20–Sept. 15.
Idaho	May 5–June 10	Aug. 1–Sept. 16.
Montana	May 15–July 15	Aug. 5–Sept. 15.
Nevada	May 1–July 15	Aug. 12–Sept. 15.
New Mexico	May 3–July 5	July 12–Sept. 28.
Oregon	Apr. 25–May 29	July 1–Sept. 1.
Utah	June 22–July 27	Aug. 5–Sept. 15.
Washington	June 12–July 1	July 5–Oct. 7 (fall rains,
Wyoming	May 1–May 15	Aug. 5–Sept. 15.

Early Hay-Fever Season.

As in other sections of the United States, the early hay fever is due principally to the pollen of the grasses (Gramineæ), including both the wild and cultivated grasses. Other pollen which contribute to vernal hay fever in this section are those of the following plants in the localities in which they are found: Bud-brush, *Artemisia spinescens;* poverty weed, *Iva axillaris;* sand-bur, *Gærtneria dumosa,* and *Gærtneria bipinnatifida.*

While all the grasses give a positive hay-fever reaction in the biological test, these naturally vary in different sections. The principal grasses responsible for hay fever in California[1] are as follows: Johnson grass, *Holcus halepensis;* Gailleta grass, *Pleuraphis rigida;* crab grass, *Syntherisma sanguinalis;* knot grass, *Paspalum distichum;* barnyard grass, *Echinochloa crus-galli;* velvet grass, *Notholcus lanatus;* Bermuda grass, *Capriola dactylon;* salt grass, *Distichlis spicata;* walk grass, *Poa annua;* blue grass, *Poa pratensis;* broncho grass, *Bromus villosus;* rye grass, *Lolium perenne,* and barley grass, *Hordeum murinum.*

In Oregon, the most common grasses are the following: Sweet vernal grass, *Anthoxanthum odoratum;* velvet grass, *Notholcus lanatus;* brome grass, *Bromus carinatus;* orchard grass, *Dactylis glomerata;* rye grass, *Lolium perenne,* and blue grass, *Poa pratensis.*

In the State of Washington[3]: Velvet grass, *Notholcus lanatus;* early hair grass, *Aira praecox;* rye grass, *Lolium perenne;* squirrel-tail grass, *Hordeum jubatum;* chess, *Bromus secalinus,* and other species of *Bromus.*

In Wyoming:[4] Western wheat grass, *Agropyron smithii;* hair grass, *Sporobolus airoides;* blue grass, *Poa pratensis;* timothy, *Phleum pratense;* crested hair-grass, *Koeleria cristata;* squirrel-tail grass, *Hor-*

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[1] Report of Professor H. M. Hall, University of California.

[2] Report of Professor Howard S. Hammond, University of Oregon.

[3] Report of Professor George B. Rigg, University of Washington.

[4] Report of Professor Aven Nelson, University of Wyoming.

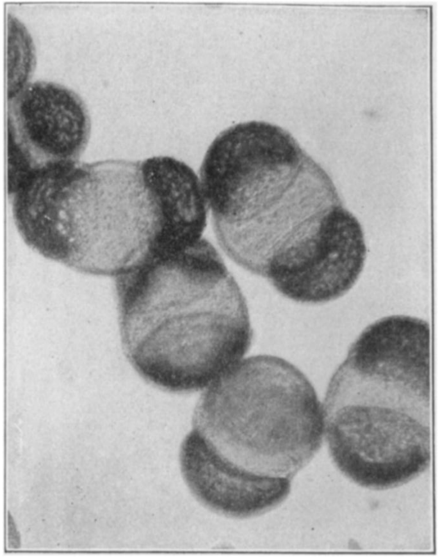

Fig. 1.—Pollen of pine (Coulter). In solution of chloral hydrate and iodine to show "wings" or "balloons" characteristic of the pine pollens and which enable them to traverse great distances. Negative in hay fever.

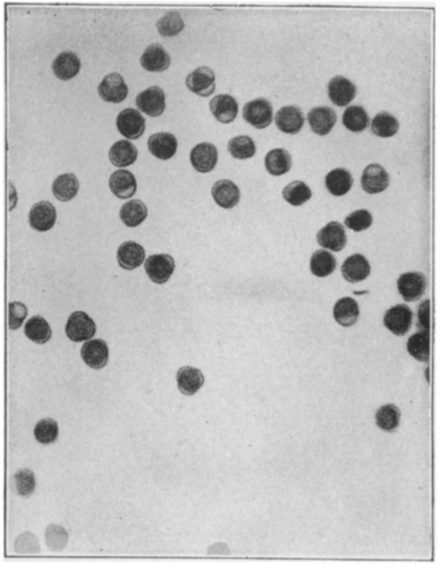

Fig. 2.—Pollen of common rag weed (Ambrosia elatior). Stained with methylene blue to show nucleus. Its small size (15 microns) gives it great buoyancy.

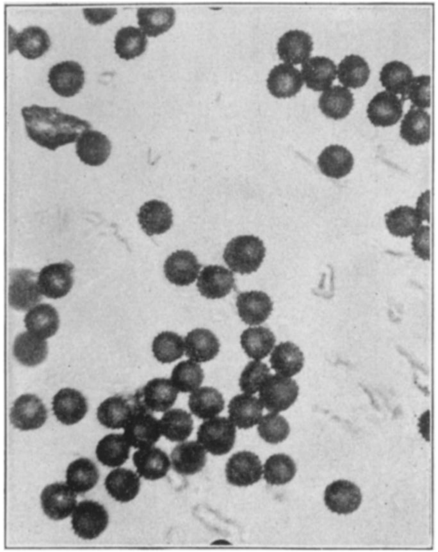

Fig. 3.—Pollen of giant ragweed (Ambrosia trifida). Its larger size (20 microns) gives it a more limited potential area than the common ragweed.

deum jubatum; reed meadow grass, *Panicularia grandis;* tall fescue grass, *Festuca elatior;* smooth lyme grass, *Elymus condensatus,* and tufted hair grass, *Deschampsia caespitosa.*

In Colorado:[1] Short-awned chess, *Bromus brizaeformis;* downy brome-grass, *Bromus tectorum;* western wheat grass, *Agropyron smithii;* Kentucky blue grass, *Poa pratensis;* orchard grass, *Dactylis glomerata;* crested hair-grass, *Koeleria cristata;* grama grass, *Bouteloua gracilis,* silk grass, *Agrostis hiemalis;* timothy, *Phleum pratense,* and squirrel-tail grass, *Hordeum jubatum.*

In Arizona:[2] Annual fescue, *Festuca octoflora;* six weeks grass, *Bouteloua aristidoides;* mesa grama, *Bouteloua rothrockii;* annual poverty weed, *Aristida bromoides;* blue grama, *Bouteloua gracilis* and silver top, *Andropogon saccharoides.*

The most common grasses in Idaho, Western Nevada, New Mexico, and Utah are the following:[3] Hungarian brome grass, *Bromus inermis;* wild oat grass, *Stipa viridula;* long-awned grass, *Aristida longiseta;* sleepy grass, *Stipa vaseyi;* false oat grass, *Trisetum spicatum;* western wheat grass, *Agropyron smithii;* bearded wheat grass, *Agropyron richardsonii,* and other tall wheat grasses.

Important Hay-Fever Plants of the Pacific and Rocky Mountain States.

While the common ragweed (*Ambrosia elatior,* fig. 4), the principal cause of fall hay fever in the Eastern States, is uncommon west of Kansas, it is found in certain sections. In some parts of Colorado it is very abundant in the towns[4] being usually found in company with the "Great ragweed" (*Iva xanthiifolia,* fig. 5). The latter should not be confused with the Great ragweed of the Eastern and Southern States, which, while belonging to the same family (Ambrosiaceae), is *Ambrosia trifida.* Their hay-fever reaction, however, is similar.

The great ragweed (*Ambrosia trifida,* fig. 6) which is a cause of autumnal hay fever in portions of the Eastern and especially in the Gulf States, is also found in a few sections of the Pacific and Mountain States. It is found in Wyoming[5] as well as the western ragweed (*Ambrosia psilostachya,* fig. 7), but is not as abundant as *Iva xanthiifolia* and sage brush (*Artemisia tridentata*).

In Arizona, some of the ragweeds are found, these being the "great ragweed" (not *Ambrosia trifida* of the Eastern States but *Ambrosia aptera*) and the "small ragweed" (not *Ambrosia elatior* of the Eastern States but *Gærtneria tenuifolia*).

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[1] Report of Professor Francis Ramaley, University of Colorado.

[2] Report of Professor J. J. Thornber, University of Arizona.

[3] Report of Professor P. L. Ricker, Assistant Botanist, U. S. Department of Agriculture, Washington, D. C.

[4] Report of Professor Theo. D. A. Cockerell, University of Colorado.

[5] Report of Prof. Aven Nelson, University of Wyoming.

The western ragweed (*Ambrosia psilostachya,* fig. 7) is so common in some parts of California that it is an important factor in hay fever[1] in that State. It is found in moist, open soil from Illinois to Saskatchewan, Texas, Mexico and California. It is a perennial weed, 2 to 6 feet high, growing from running root stocks, thicker and stouter than the common ragweed, covered with loose shaggy white hairs; leaves thick, much divided, the lobes of the leaves lanceolate and acute; the staminate heads on short pedicels; the fruit solitary in the axils below.

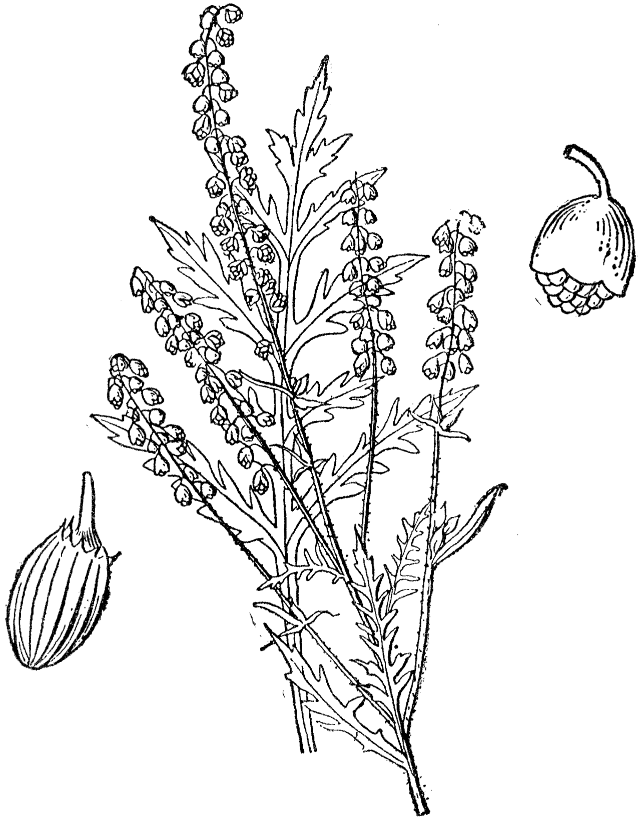

FIG. 4.—Common rag weed (*Ambrosia clatior*). The principal cause of hay fever in the Eastern and Southern States. (From "Illustrated Flora of North America," by Britton and Brown.)

The most important hay-fever weeds of the Pacific and Mountain States, and which give the most severe reaction, are the wormwoods (*Artemisias*). While their pollen is not produced in the same profusion as that of the ragweeds (*Ambrosias*), they give a marked hay-fever reaction which in some species is five times[2] as active as that of the ragweeds (*Ambrosias*). The pollens of all the *Artemisias* examined are three-lobed, and are all smooth with exception of *Artemisia biennis*, which is slightly spiculated.

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[1] Report of Prof. H. M. Hall, University of California.

[2] The *Artemisia heterophylla* produces a reaction in dilutation of 1 to 100,000.

In California, *Artemisia heterophylla* (mugwort) and *Artemisia tridentata* (sagebrush, fig. 8) are the principal hay-fever plants.

In Oregon the *Artemisias* are also the principal cause, being far more abundant than other hay-fever weeds, such as the *Ivas, Xanthiums, Gærtnerias* and *Ambrosia psilostachya*,[1] and this is the case in most of this section except in the moist region near the Pacific Coast. In Colorado[2] on the western slope of the mountains, *Artemisia tridentata* covers vast areas almost to the exclusion of other plants. In the sagebrush district persons suffer a great deal from what is popularly called "mountain fever." This has all the symptoms of severe hay fever and is prevalent from August to November, the period of pollination of the sagebrush, and is evidently due to the pollen of the *Artemisia tridentata*.

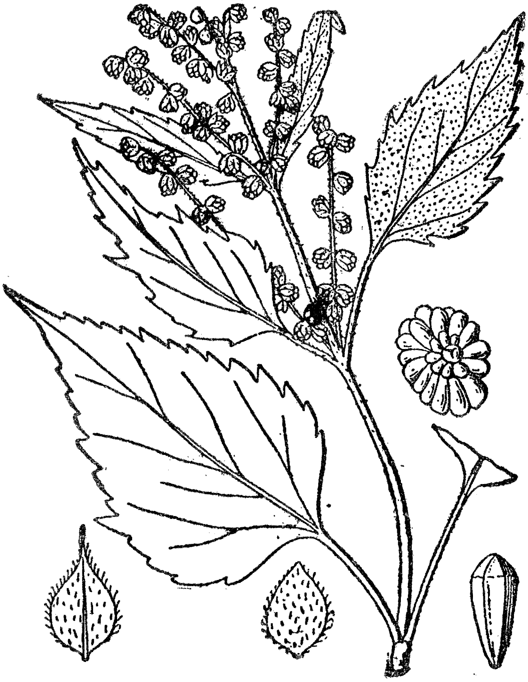

FIG. 5.—Bur marsh elder, also known in the West as the "great rag weed" (*Iva xanthiifolia*). Grows in moist soil and is a cause of hay fever from Idaho and Saskatchewan, Iowa to Mexico, but is not found on the Pacific Coast. (From "Illustrated Flora of North America," by Britton and Brown.)

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[1] Report of Prof. Howard S. Hammond, University of Oregon.

[2] Report of Prof. Theo. D. A. Cockerell, University of Colorado.

In view of the importance of the Artemisias from a hay-fever standpoint a description of the most common varieties is given:

The Artemisias in the Rocky Mountain and Pacific States.[1]

Artemisia is a genus of mostly bitter and aromatic herbs and shrubs, of which the European wormwood is perhaps the best known. It belongs to the mayweed section of the Compositæ family, but, unlike the mayweed, the flower heads of *Artemisia* are small, inconspicuous, and without rays. In some cases the flowers are apparently self-pollinated; in others the pollen is wind-carried, and in these it is produced in great abundance. There is no reason to suppose that insects aid in their pollination. Only those which are wind-pollinated are important from a hay-fever standpoint.

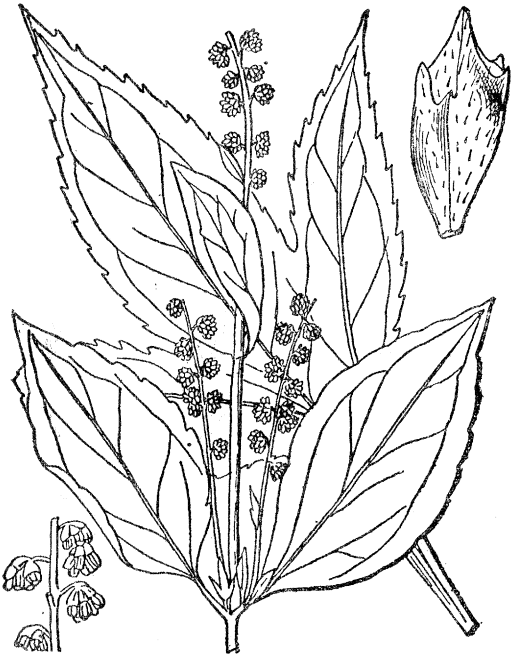

FIG. 6.—Giant rag weed (*Ambrosia trifida*). Replaces the common rag weed (*Ambrosia elatior*) in most parts of the Eastern and Southern States and is also found in some sections of Nebraska, Colorado, and New Mexico. (From "Illustrated Flora of North America," by Britton and Brown.)

The genus comprises some 200 species. Its greatest development is in the Mediterranean region and in arid North America. About 50 species are found native in the Rocky Mountain and Pacific States, but most of these are of limited distribution, or occur only at high altitudes, or because of some other peculiarity are not important as causes of hay fever. On the other hand, a few of the species grow in great abundance in the neighborhood of towns and in agricultural districts, where they constitute a serious menace. The California mugwort (*Artemisia heterophylla*) is perhaps the most common of these on ditch banks and in waste places, while the Sagebrush (*Artemisia tridentata*) is the most abundant shrub in the Great Basin area. Both of these have been tested in the Biological Laboratory of the American Hay-Fever-Prevention Association and have been found to give a marked hay-fever reaction.

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[1] Report of Prof. H. M. Hall, University of California.

California mugwort, *Artemisia heterophylla.* This name includes several forms, some of which are considered as distinct species by some botanists, but they are all much alike and the properties of the pollen are probably the same for all. The mugwort is an erect perennial herb 3 to 8 feet high. The leaves are rather broadly oblong, 2 to 4 inches long, either cleft or entire, and green above but white beneath. The plants are in bloom from about July 1 to late autumn. They grow either scattered or in masses, often forming thickets on river banks or along ditches. They are especially common on low, moist land.

The banks on which mugwort grows are usually too uneven to permit cutting by mowing machines, but it could be cut by hand with a scythe. The plants would grow up again from the roots, but by cutting the tops occasionally the amount of pollen could be greatly reduced. In suitable situations, the mugwort may be expected anywhere from southern California to British Columbia, and east as far as Nevada. It does not grow above an altitude of about 5,000 feet, but from Oregon to Alaska it is replaced by the closely-related *Artemisia tilesii*, which ranges higher.

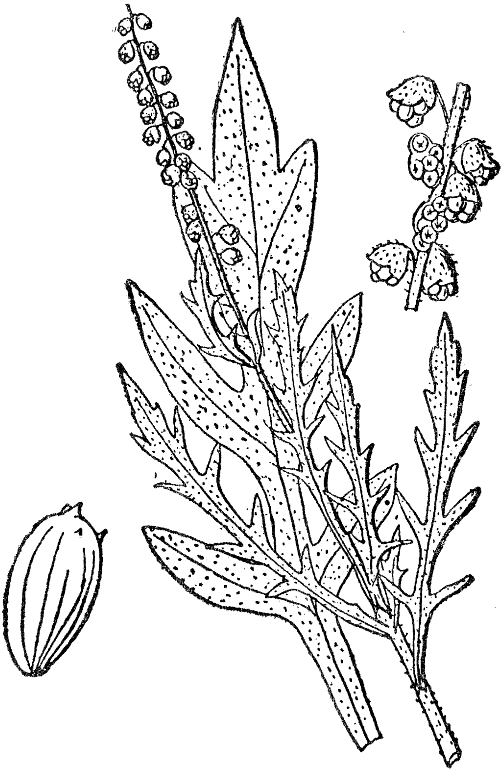

FIG. 7.—Western rag weed (*Ambrosia psilostachya*), western representative of the rag weeds (*Ambrosias*). Moist open soil from Illinois to Saskatchewan, Texas, Mexico, and California. (From "Illustrated Flora of North America," by Britton and Brown.)

Dark-leaved mugwort, *Artemisia ludoviciana.* In general habit this species is much like the mugwort, but the leaves are usually narrower and are whitened on both faces by a woolly pubescence, at least when young. (In *Artemisia gnaphalodes*, a very closely related species and likewise common, the leaves are permanently and densely white-hairy.) It grows in waste places, especially in dry, stony stream beds. In California it is quite scattered, only occasionally growing in masses, but it is much more common in the Northwest and in the Rocky Mountains, where it grows both on the plains and on stream banks. Its period of bloom and the method of control are similar to those indicated for the mugwort.

"Indian hair tonic," *Artemisia dracunculoides*. The stems of this perennial herb are stiffly erect and grow to a height of 4 to 6 feet. Unlike most artemisias the herbage is glabrous and green. All of the other species here described, except *Artemisia biennis* have a gray or whitish herbage. The leaves are mostly entire, 1 to 3 inches long and less than ¼ inch wide. June to September is the period of bloom. Next to the sagebrush, this is perhaps the most plentiful species in western North America. It grows in mountain valleys and on the plains, but is generally absent from the deserts. Sometimes it forms dense stands. In such cases its subjection by mowing would seem feasible.

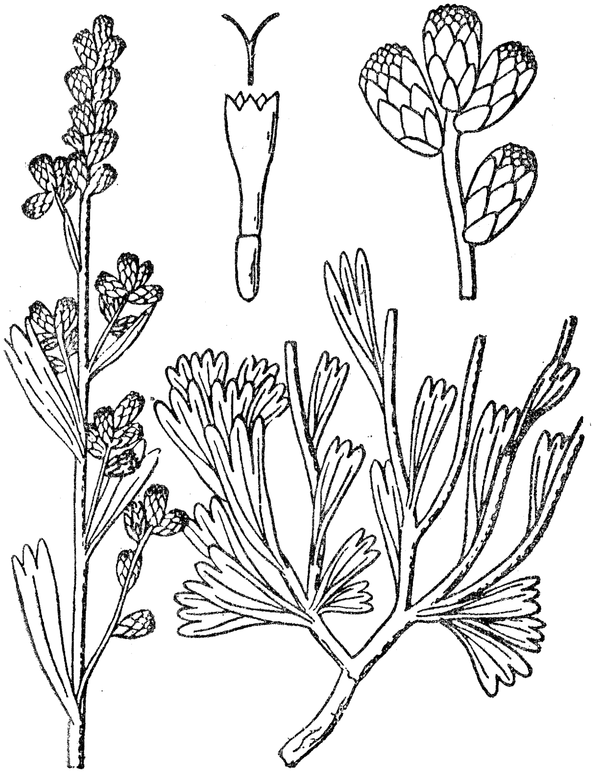

FIG. 8.—Sagebrush (*Artemisia tridentata*). A cause of hay fever over an extended area, as it grows from New Mexico and Lower California north as far as Washington and Montana. (From "Illustrated Flora of North America," by Britton and Brown.)

Sagebrush (Fig. 8), *Artemisia tridentata*. The sagebrush is an erect, much-branched, gray shrub with a distinct trunk and shreddy bark. The narrowly wedge-shaped leaves are only ½ to 1½ inches long and mostly 3-toothed across the summit, although some of the upper ones are narrower and not toothed. The pollen is produced from August to November. This shrub grows from New Mexico and Lower California, north across the high plains of the Great Basin States, extending even into Washington and Montana. It is by far the most abundant and best-known shrub in this whole region, forming the principal vegetation over thousands of acres. It belongs to the arid districts of plains and mountains but does not grow near the coast nor in the hot deserts of the south. In California it is scarcely known west of the Sierra Nevada. The sagebrush is sometimes known as "black sage," but it is not to be confused with the true black sage nor with the white sage, both natives of Southern California. These true sages belong to the mint family and do not cause hay fever. Because of its woody, almost arboreous habit and great abundance, the elimination of sagebrush will form a difficult problem.

Bud brush, *Artemisia spinescens*. This is a low, gray shrub with many stiff branches ending in spines. It grows ½ to 1½ feet high. The very small leaves are densely white-hairy and much lobed. The flowering period is earlier than that of most Artemisias, the pollen being produced from March to June. The bud brush grows on sandy or somewhat alkaline soil from the Mohave Desert of California, north and east to eastern Oregon, Wyoming, and Colorado. It is especially common in Nevada and Utah. Eradication is difficult because of the woody nature of the stems.

"California old man," or hill-brush, *Artemisia californica*. This is a gray, highly aromatic shrub, 2 to 4 feet high, best identified by its leaves, which are parted into almost thread-like segments. It blossoms from June to October. Geographically it is restricted to the hills of the Coast Ranges from middle California southward, but there it often forms dense growths of considerable area, especially in southern California. Since the stems are decidedly woody the eradication of this plant is also difficult.

Wormwood sage, *Artemisia frigida*. The stems of this plant are woody at base and mostly 1 to 1½ feet high. The herbage is gray and soft because of the many short hairs which cover it, and the leaves are finely cut into linear lobes. The plant blooms from July to October. It grows from Idaho, Nevada, and New Mexico, to Minnesota and Texas, and is especially common on the plains of Utah and Colorado. There is much of it around Denver. In Estes Park, Colo., hay fever is coincident with the blooming of the wormwood sage.

Biennial wormwood, *Artemisia biennis*. This is an erect herb 1 to 3 feet high. It grows from a slender annual or biennial taproot, whereas all others here described have tough, perennial roots, many of them more or less woody. The leaves are green and scarcely at all hairy. They are 1 to 3 inches long and deeply cleft into narrow lobes which are sharply toothed. The pollen is shed from July to December. This plant occupies open places, especially ditch banks and neglected yards, throughout western North America, but is not often present in large amounts. It can be destroyed easily by pulling, especially when the ground is soft, since the root is not deep.

Artemisia cana, *Artemisia canadensis*, and *Artemisia discolor*, as well as a few others, may be found in quantity at a few places but usually not in proximity to closely populated districts.

Artemisia absinthium, the common wormwood, seems to have been introduced with seed into eastern Washington, adjacent to Idaho and Oregon. It is spreading rapidly throughout those localities.[1]

The Ivas, Gærtnerias and Cockleburs.

Next in importance to the Artemisias are the burweed marsh elder, or "Great ragweed" (*Iva xanthiifolia*), and the rough marsh elder (*Iva axillaris*).

Their pollens, which are spiculated like those of the rag-weeds (Ambrosias), also give a similar reaction for hay fever.

IVAS.

Western elder or povertyweed, *Iva axillaris*. (Fig. 9.) The povertyweed belongs to the ragweed section of the Compositæ family but is unlike all the ragweeds in its leaves, which are only an inch long, sessile, and not at all toothed or cut. The stems are not woody but grow from perennial creeping rootstocks, so that eradication would be extremely difficult. Cutting close to the ground at the beginning of the flowering season would greatly reduce the amount of pollen produced, but the stems would again shoot up from the same rootstocks. The plants grow in alkaline or saline soil from the Rocky Mountains to the Pacific Coast and from Canada to Mexico. The blooming period is March to September.

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[1] Report of Prof. Howard S. Hammond, University of Oregon.

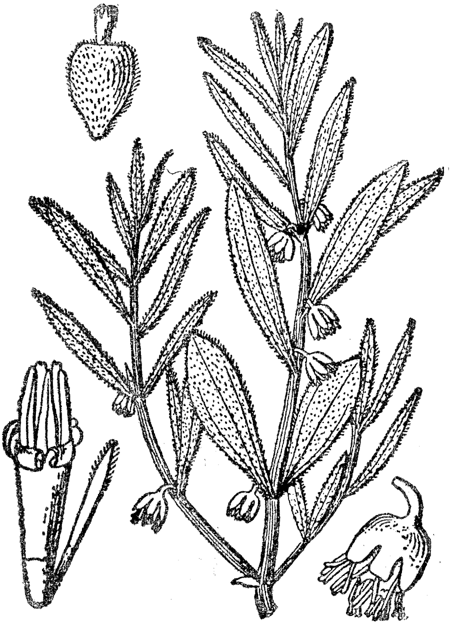

FIG. 9.—Poverty weed or western elder (*Iva axillaris*). A cause of hay fever. Alkaline or saline soil from the Rocky Mountains to the Pacific Coast and from Canada to Mexico. (From "Illustrated Flora of North America," by Britton and Brown.)

Burweed marsh elder or great ragweed, *Iva xanthiifolia.* (Fig. 5.) This is a tall, coarse, annual weed with ovate, sharply toothed leaves 2 to 6 inches long. In habit and foliage it resembles the common sunflower, although it is not so large, but the small, homely heads of flowers are borne in long terminal clusters. It grows from Idaho and Saskatchewan south to New Mexico but is absent from the Pacific coast. It blooms in late summer and autumn. Since the root is of only annual duration, any practice which will prevent the plants from going to seed will be effective as a method of eradication. Mowing is advisable where the plants grow in dense stands.

Next to the Artemisias and Ivas, the Gærtnerias were found to be important as an active cause of hay fever. Their pollen, which resembles that of the common ragweed (*Ambrosia elatior*) so closely that it is difficult to distinguish microscopically, also gives a similar reaction.

GÆRTNERIAS.[1]

Gærtneria (sometimes called *Franseria*) is a genus of herbs and low shrubs with alternate leaves which are often gray with short stiff hairs and usually lobed or toothed. It belongs to the ragweed section of the Compositæ family and has pistillate and staminate flowers on the same plant as in the ragweeds. The Gærtnerias differ from the ragweeds in the burs which surround the pistillate flowers; these burs are armed with several rows of spines or prickles, while those of the ragweeds have the prickles arranged in a single circle. It is probable that the species are all wind-pollinated, but some of them may be self-pollinated. The most common species in the West are the following:

Sand bur, *Gærtneria dumosa.* The sand bur is a low, spreading, white-stemmed shrub, with brittle, woody branches. The leaves are less than an inch long, parted into many small lobes and white with minute hairs, which cover the surface. It grows in great abundance on the hot, dry deserts from southern Utah to southeastern California and southern Arizona. It is very common along some of the railways crossing the southwestern deserts. The flowers shed their pollen from about the first of March to the end of June.

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[1] Report of Prof. H. M. Hall, University of California.

False ragweed, *Gærtneria acanthicarpa.* (Fig. 10.) This is a spreading and bushy annual or biennial weed. The leaves are ashy gray, ovate in outline, but cut into short, rounded lobes somewhat as in ragweed. The flat spines of the bur are straight or only slightly curved. This species inhabits sandy plains and stubble and is common in arid sections from the Rocky Mountains to the Pacific coast. In California it is restricted to the southern and eastern parts of the State, and similarly in Oregon and Washington it is found only in the drier parts away from the coast. It is reported as one of the commonest weeds in New Mexico. The blooming period is August to December. Since the roots are short-lived, the weed may be easily held in check by mowing or burning before the burs ripen. Hand pulling is very effective, and may be practiced where the area covered is not too large.

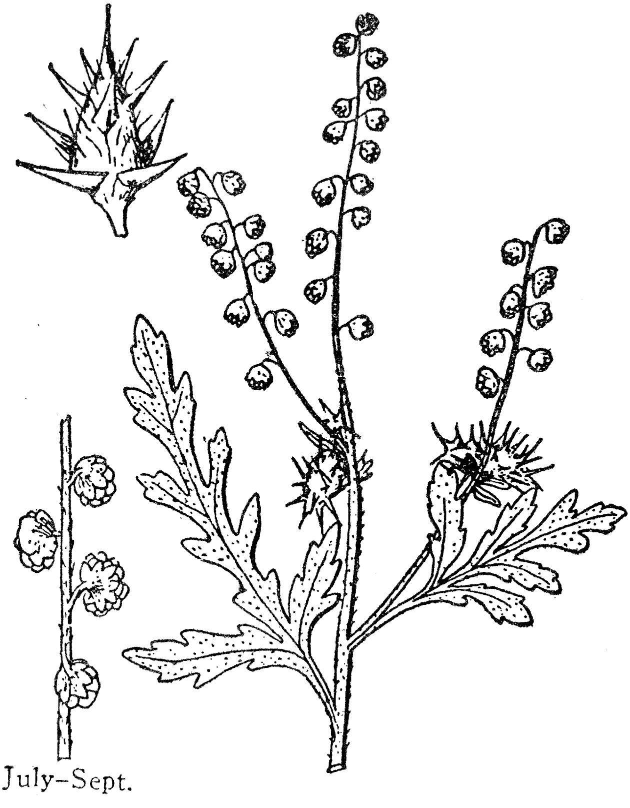

FIG. 10.—"False rag weed" (*Gærtneria acanthicarpa*). A common cause of hay fever. In sandy plains and stubble on the arid sections from the Rocky Mountains to the Pacific coast. (From "Illustrated Flora of North America," by Britton and Brown.)

Gærtneria tenuifolia. This perennial very closely simulates the western ragweed in general appearance, but may be distinguished by the burs, which have more than one row of spines, and these are incurved or hooked. It grows in warm, dry districts from the westerly part of the Mississippi Valley to Colorado, Nevada, and southern California, and ranges south to Texas, but it is not so common as the other species. The pollen is produced during late summer and autumn.

Gærtneria bipinnatifida. The stems of this plant spread along the ground from a perennial root. The white-hairy leaves are much cut into spreading lobes. The burs form in dense clusters toward the ends of the branches, and each cluster is surmounted by a fingerlike projection made up of the staminate heads, which yield the pollen. This pollen is produced from April to December. The species grows only on the seashore, usually on the beach sands or dunes, and extends from Lower California to British Columbia. From middle California northward it is accompanied by *Gærtneria chamissonis*, a very closely related species with merely toothed or cut leaves. Either sort would be difficult to eradicate because of the deep, perennial roots.

COCKLEBURS.

The cockleburs (*Xanthium*) give a positive reaction for hay fever, but less marked than the *Artemisias*, *Ambrosias*, *Ivas*, and *Gærtnerias*. The pollen is also spiculated, but their large size (36 microns) reduces their potential area. It is abundant in some localities, especially on bottom lands along the rivers. It is a coarse annual, with branching stems and alternate petioled leaves. Leaves broadly ovate, cordate, usually three-lobed, and simply or doubly dentate. Sterile and fertile flowers in different heads, the latter clustered below, the former in short spikes. The fruit, a rough bur, usually has two curved beaks and is covered with prickles straight-tipped or hooked, 2 to 6 feet high. It blooms from June to December.

Other Hay-Fever Plants of the Pacific and Mountain States (Minor Importance).

The hay-fever plants of minor importance in this region are the following: Dock, *Rumex conglomeratus* and *obtusifolius;* sheep sorrel, *Rumex acetosella;* goosefoot or lamb's quarters, *Chenopodium ambrosioides;* tumbleweed, *Amaranthus græcizans* and salt bush, *Hymenoclea salsola.* Most of these plants generate pollen in abundance, but these produce only a mild hay-fever reaction similar to that of the docks, *Rumex crispus,* and amaranths, *Amaranthus spinosus* of the eastern States.

Among the trees, the pollen of the majority have proven either negative or so slight in reaction as to be of little importance in hay fever. An exception, however, is the cottonwood (*Populus*). Of the varieties tested, the pollen of *Populus sargentii* (fig. 11) gives a marked reaction and is responsible for hay-fever cases in localities in which it is found in sufficient quantities. *Populus angustifolia* gives a much milder reaction, and also the Arizona cottonwood, *Populus arizonica.*

Plants Not Responsible for Hay Fever.

While describing the plants which are responsible for hay fever, it is also opportune to say a few words regarding the much abused roses and goldenrods. The rose is insect pollinated and could, therefore, cause hay fever only on direct inhalation, as the pollen is never found in the atmosphere. In addition to this, its reaction is practically negative, so that in spite of the common term applied to the early hay-fever rose cold it is not responsible for hay fever.

The goldenrod has a spiculated pollen (20 by 22 microns), which gives a positive hay-fever reaction. The flowers, however, are insect pollinated and cause hay fever only on direct inhalation or when used for ornamental purposes, as in room decorations. In most sections the goldenrod continues to bloom many weeks after the hay-fever season is over. In the atmospheric-pollen plates exposed in New Orleans during the whole of the past hay-fever season the pollen of the goldenrod (*Solidago*) was never found.[1] In spite of its reputation, therefore, the goldenrod is an insignificant factor in hay fever.

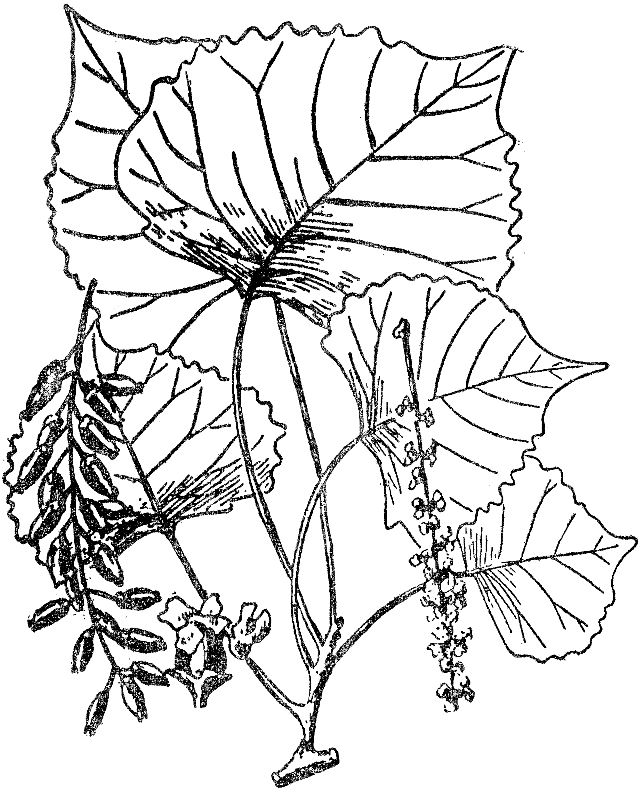

FIG. 11.—Western cottonwood (*Populus sargentii*). One of the few trees whose pollen cause hay fever. River bottoms Saskatchewan to North Dakota, Nebraska, Kansas, and New Mexico. (From "Illustrated Flora of North America," by Britton and Brown.)

Another falsely accused plant, whose reputation, however, is limited to the Rocky Mountain States, is the resin weed, *Grindelia squarrosa* (fig. 12), which is blamed in Wyoming and the adjoining States for the prevalence of hay fever. Specimens of this were sent to a biological laboratory by Dr. W. A. Wyman, of the Wyoming

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[1] "Hay-fever and Hay-fever Pollens," W. Scheppegrell, M. D. The Archives of Internal Medicine, June 15, 1917.

State Board of Health. The pollen was found to be spiculated and measures 20 microns in diameter, which is the size of the *Trifida* ragweed pollen, which it also resembles very closely microscopically.

The pollen, however (fig. 13), like the flowers, is sticky and resin-like, as implied by the popular name. The pollen itself gives a positive reaction, but as it is not wind-borne, and therefore not in the atmosphere, it is not a cause of hay fever. The probability, therefore, is that the resin weed, on account of its prevalence and conspicuousness, was selected in the same manner that the goldenrod has been so long held responsible for hay fever, while the real but insignificant hay-fever weeds were unsuspected.

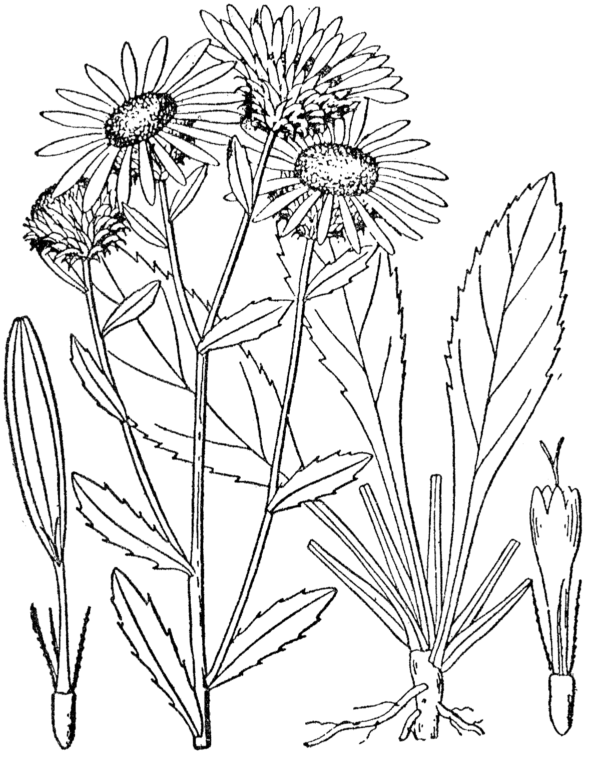

FIG. 12.—Resin weed (*Grindelia squarrosa*). Popularly supposed to be the cause of hay fever in Arizona, Wyoming, and the adjacent States. The plant is harmless, as it is not wind-pollinated. (From "Illustrated Flora of North America," by Britton and Brown.)

Potential Area of Pollen Distribution.

In regard to the responsiblity of the noxious plants for hay fever, this depends, first, on the proximity of these plants and, secondly, on the size of the pollen, which has a marked effect on their buoyancy. As already stated, the pollen of corn, in spite of its toxicity, is rarely responsible for hay fever, as its relatively great size (80

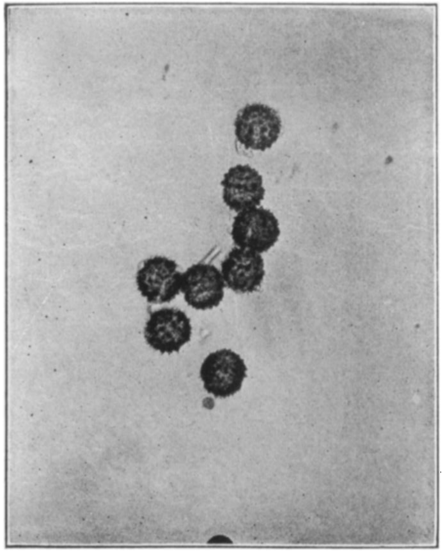

Fig. 13.—Pollen of resin weed (Grindelia squarrosa). Resembles the pollen of the common ragweed, but is not found in the air and therefore does not cause hay fever.

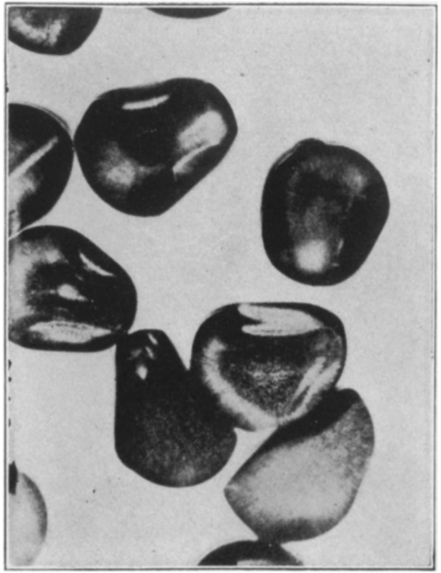

Fig. 14.—Pollen of corn. Its large size (80 microns) limits its potential area to a few yards from the plants.

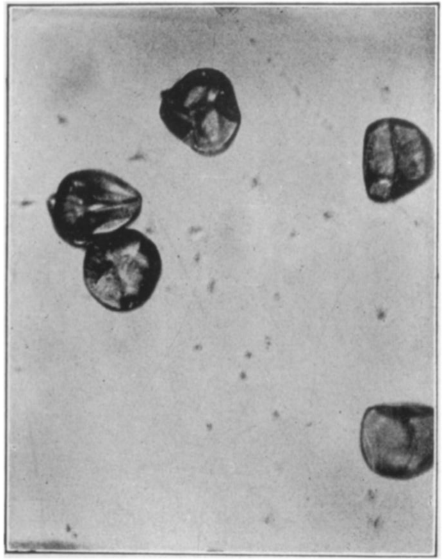

Fig. 15.—Pollen of foxtail grass (Chaetochloa glauca). The relatively large size of the grass pollens (average 40 microns) limits their potential area, which greatly facilitates municipal efforts for their control.

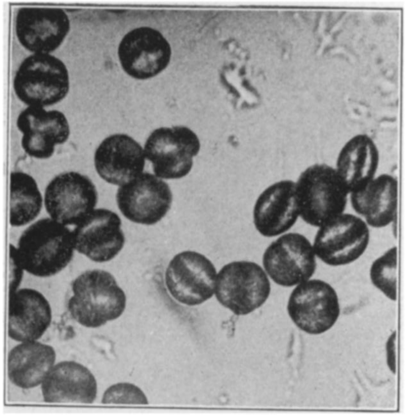

Fig. 16.—Pollen of mugwort (Artemisia heterophylla). One of the most important hay-fever pollens of the West. Grows in low soil from Southern California to British Columbia and Nevada.

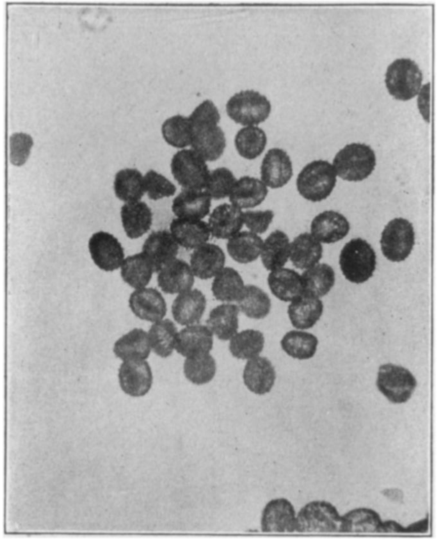

Fig. 17.—Pollen of bur marsh elder (Iva xanthiifolia). Important cause of hay fever. Moist soil from Ontario to Assiniboia and south to Wisconsin, Nebraska, New Mexico, and Utah.

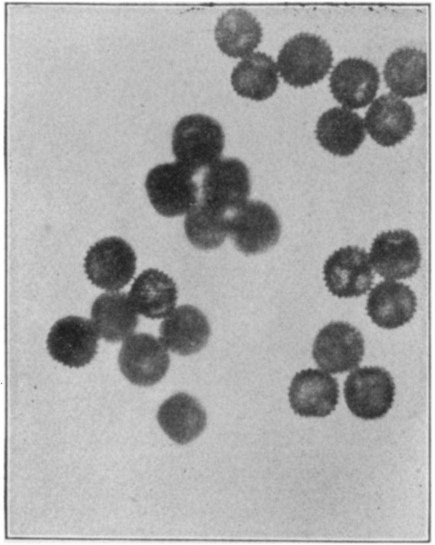

Fig. 18.—Pollen of western ragweed (Ambrosia psilostachya). Its larger size (25 microns) gives it only one-sixth of the potential area of the common ragweed (Ambrosia elatior, 15 microns).

microns, fig. 14) reduces its potential area to a short distance from the plant. The other extreme is the pollen of the common ragweed (*Ambrosia elatior*), whose pollen measures 15 microns (fig. 2) and whose buoyancy is so great that a wind velocity of 20 miles or more will carry it several miles.

Most of the grasses have pollen of considerable size (35 to 55 microns, fig. 15), so that their pollen is not carried to a great distance. On this account, municipal efforts for the control of the early hay fever due to these grasses have been attended with considerable success.

While the pollen of the *Artemisias* (fig. 16) gives a severe reaction, their potential radius is reduced by the size of their pollens (average 24 microns) to about one-sixth of that of the common ragweed (15 microns). Their pollen also, although produced in great quantities, is many times less abundant than that generated by the ragweeds, and the resulting infection of the air is, therefore, proportionately less.

The bur marsh elder, *Iva xanthiifolia,* has spiculated pollen (fig. 17) which gives a reaction similar to the *Ambrosias.* Its pollen which is ovoid, measures only 15 by 20 microns, which gives it a considerable potential area. The western ragweed, *Ambrosia psilostachya,* has a pollen (fig. 18) similar to the common and great ragweeds (*Ambrosia elatior* and *trifida*), but as the pollen is larger (25 microns) it has a much more restricted potential area.

The *Gærtnerias* give a reaction similar to the ragweeds (*Ambrosias*). The pollen is also spiculated and their small size (average 17 microns) gives them a considerable potential area.

Prevention.

The prevention of hay fever by the eradication of the weeds that produce the noxious pollen is a more complicated problem in the Pacific and Rocky Mountain States than in the Eastern States. This is due to the fact that the fall hay fever is caused by the pollen of a larger number of plants.

In the early (vernal) form of hay fever, which in all the States is due principally to the pollen of the grasses (*Gramineæ*), this presents no great difficulty. The potential area of the grass pollens is not great and the enforcement of suitable grass-weeds ordinances should be sufficient practically to eliminate grasses as a factor.[1]

The fall hay fever, however, which is due principally to the pollen of the *Artemisias*, *Ivas*, and *Gærtnerias*, presents greater difficulty both on account of the larger number of these plants and the greater buoyancy of their pollen.

While the fall hay fever of the eastern States is due almost entirely (85 per cent) to the pollen of the common ragweed (*Ambrosia elatior*), the fall hay fever of the Pacific and Rocky Mountain States is due to many varieties of the *Artemisias*, as well as of several of the *Ivas* and *Gærtnerias* and also to the western ragweed (*Ambrosia psilostachya*).

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[1] The New Orleans grass-weeds ordinance, adopted Jan. 25, 1916, was published in the Public Health Reports of Aug. 25, 1916, p. 2310.

The larger number of plants, however, is offset by the far greater buoyancy of the pollen of the common ragweed of the Eastern States. Measuring only 15 microns in diameter and having a spiculated surface, which adds almost 50 per cent to its buoyancy, the potential area of the common ragweed pollen is so great that it will traverse several miles in a wind of 20 miles per hour, as has been frequently demonstrated by atmospheric-pollen plates.

The *Artemisias*, however, on account of the size of their pollen, which average about 24 microns, will traverse only about one-sixth of the area of the common ragweed, this area being still more reduced by the fact that their surface is smooth instead of spiculated, as in the ragweeds. In spite of the great prevalence of these plants, therefore, legislative measures for their eradication from the vicinity of municipalities should prove quite effective. This also applies to the western ragweed (*Ambrosia psilostachya*) whose pollen measures 25 microns, which also restricts its potential area of distribution.

The *Gærtnerias*, however, which bear a resemblance to the ragweeds both in the spiculated pollen and in their hay-fever reaction, also have a light buoyant pollen (average 17 microns) which give them an extended potential area. On this account special efforts should be made to eliminate them from the neighborhoods of communities.

The education of the public in the noxiousness of these weeds from a hay-fever standpoint is of the greatest importance. When this has been accomplished, suitable legislation will be enacted. When we observe the stringent laws enacted by various States for the exclusion of parasites injurious to their agricultural interests, suitable legislation for the protection of the large number of hay-fever sufferers should present no great difficulty.